Transforming Agriculture into Renewable Materials

Ohio BioProducts Innovation Center

Integrated Biorefinery

Feedstocks

agriculture/ forestry

crops/residue

wood residue

livestock manure

industrial/ municipal

municipal solid waste

CO_2 emmissions

food/industrial byproducts

Processes

extraction/ separation

mechanical, chemical

bioconversion

microbes, algae

hydroloysis

acids, enzymes

gasification

high heat, low oxygen

pyrolysis

catalysis, heat, pressure

Uses

food

oil
proteins
carbohydrates
additives

fuels/energy

ethanol/butanol
biodiesel
heat
electricity

materials

plastics
fibers
adhesives
rubber
paints/coatings
dyes/pigments/ink
detergents/solvents

Importance of Polymers to Ohio

US Market Position

Importance of Polymers to Ohio

paints & coatings

US Market Position

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adhesives

Importance of Polymers to Ohio

paints & coatings

US Market Position

adhesives

rubber

Importance of Polymers to Ohio

paints & coatings

US Market Position

adhesives

rubber

soaps

Importance of Polymers to Ohio

Plastic is Ohio's #4 export

Current Source of Polymers

Oil

U.S. Petroleum Market

use	value	value/share
≈ 67% transportation fuel (auto, air, truck, rail, etc)	$350 billion	$5.2 billion
≈ 7% materials (chemicals, polymers, etc)	$255 billion	$36.4 billion

7x

Source: Frost (2005). *Industrial Biotechnology, Vol.1(1) .*

Why BioProducts

Future of Oil

- Increasing Global Demand
- Uncertain Supply
- Volatile Price

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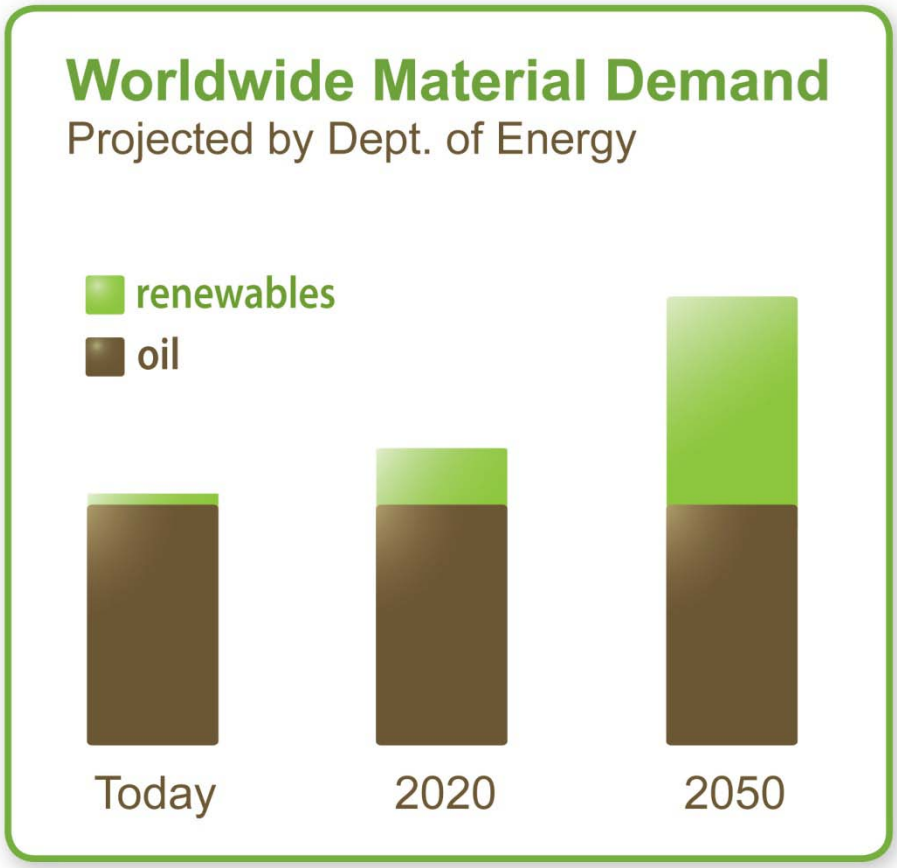
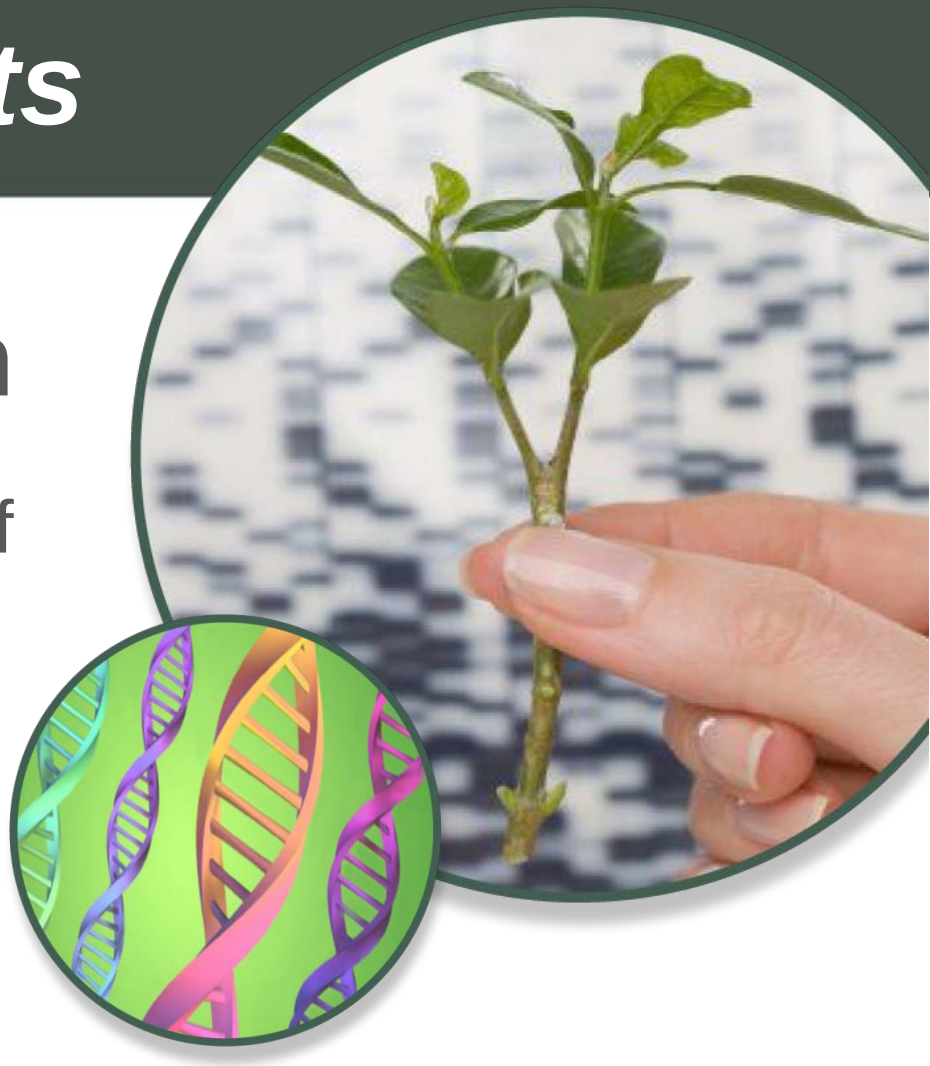


Why BioProducts

Impact of BioTech

- Utilize natural diversity of plant kingdom
- Design plant traits
- Target specific chemical functionality



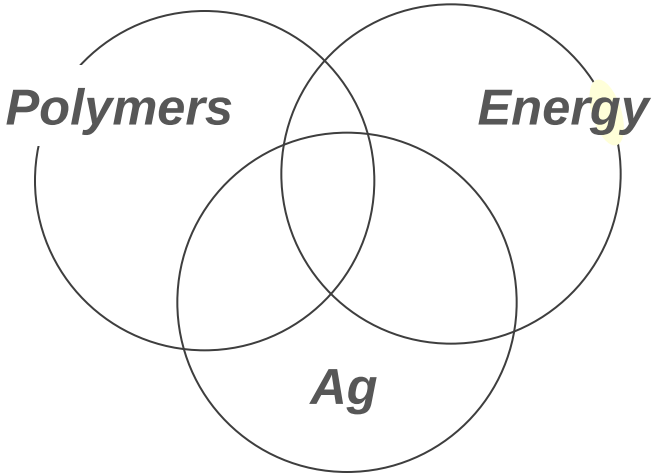
Why BioProducts

Renewable biopolymers are important sources of innovation.

NE Ohio Polymer Strategic Roadmap
Battelle, 2004

Industry & Technology

ECONOMIC SECTORS



NEW TECHNOLOGY

Nanotechnology
Biotechnology

Polymer Photonics
Agbiosciences
Sensors
Biochemistry

OUTCOMES

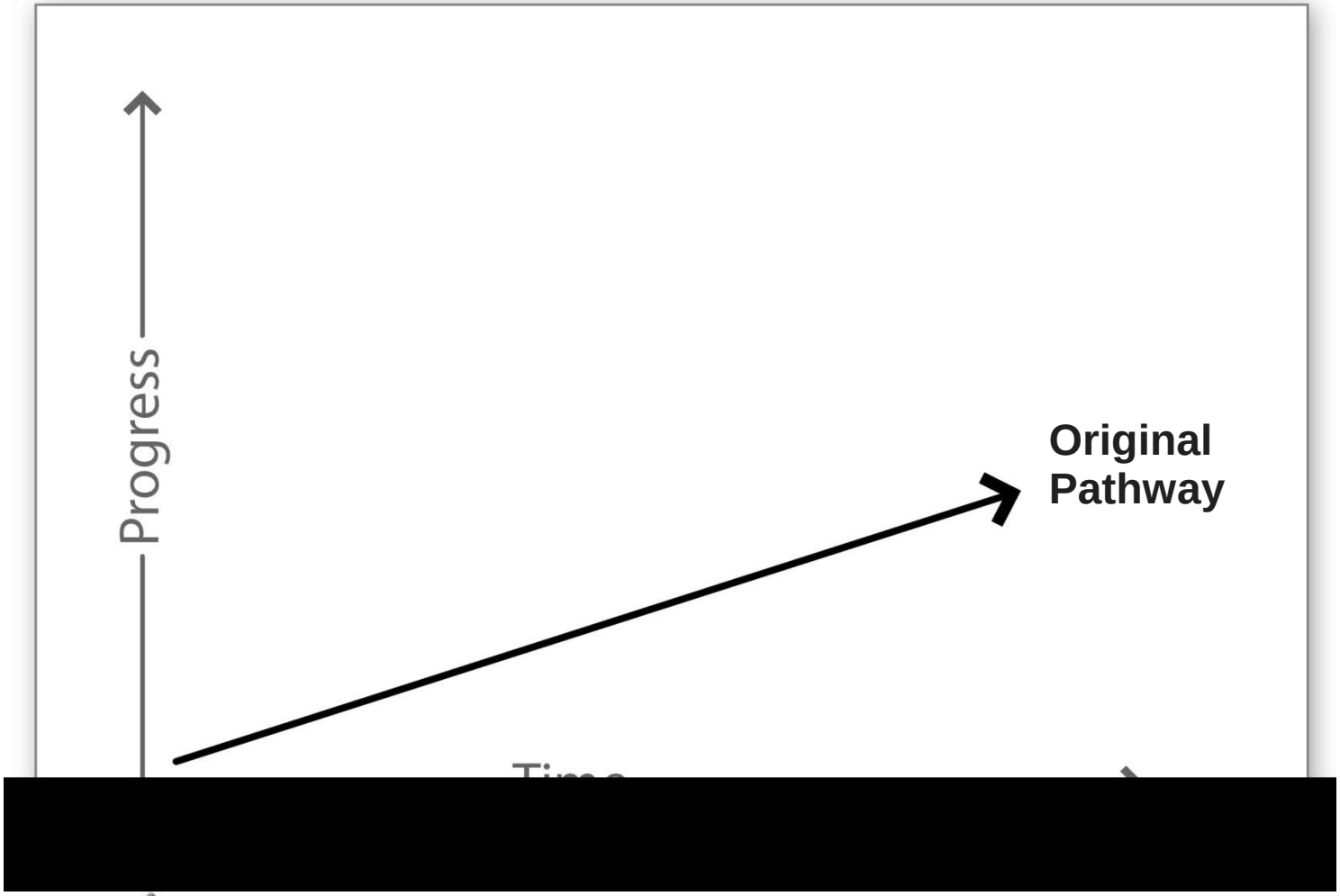
Growing Existing Companies

- Polymer & Ag
- Wind turbines
- Solar Energy
- Flexible Electronic Displays
- Energy Storage
- Medical devices

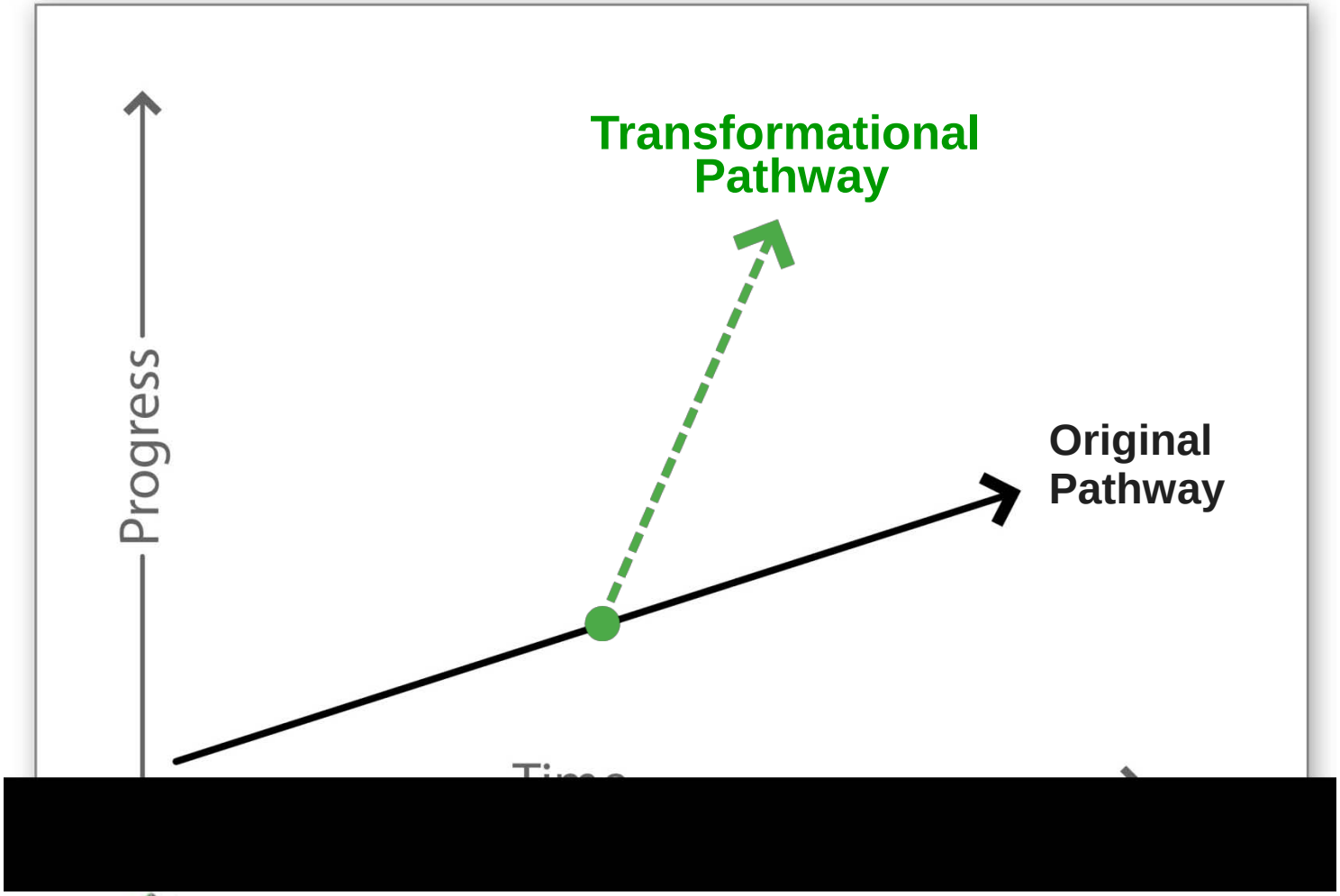
Building New Industries

- Biorefinery
- Smart materials
- Fuel Cells
- Hi-perf structures
- Drug delivery devices
- Nanofoams
- Biomass to Energy

Rate of Innovation



Rate of Innovation



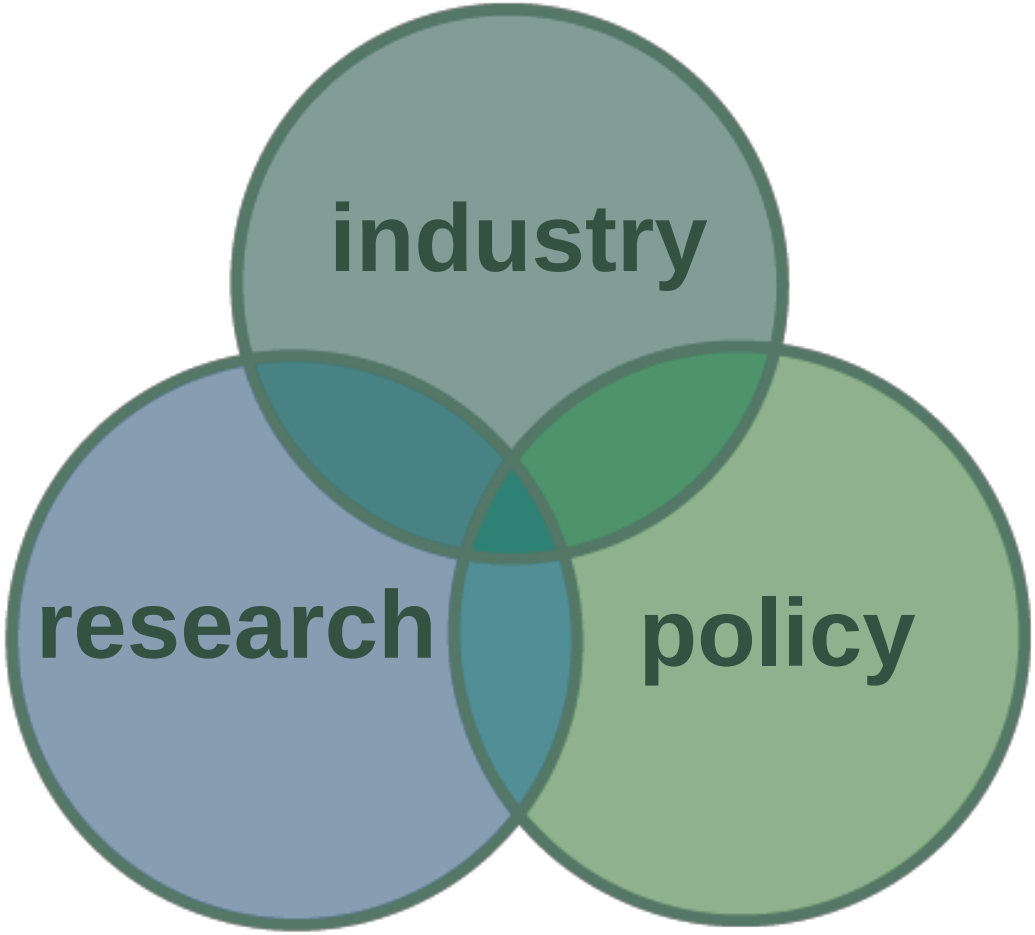
OBIC Overview

Established June 2005 by
$11.5 million grant from
Ohio's Third Frontier Program

Key Strategies:

- Targeting investments to enhance research capabilities
- Fostering innovation through academic/ industry networks
- Linking research to address industry needs

Networks are Key to Innovation



Bridging Ohio's Top Industries

agriculture
$93 billion

OBIC

polymers
$49 billion

Industry Leaders

Research Collaborators

THE OHIO STATE UNIVERSITY

Battelle
The Business of Innovation

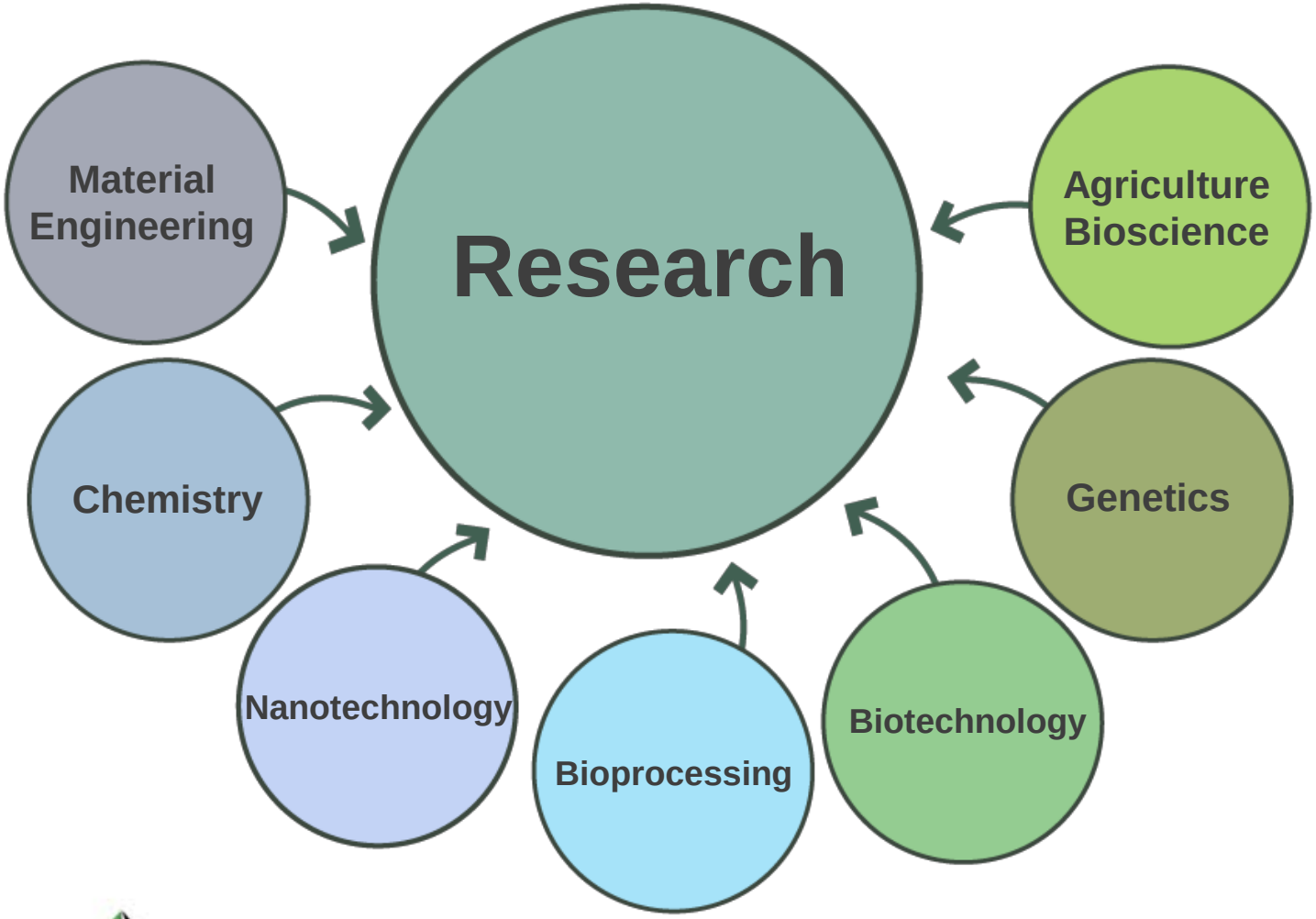
THE UNIVERSITY of AKRON
Applied Polymer Research Center

U.S. Department of Energy National Labs

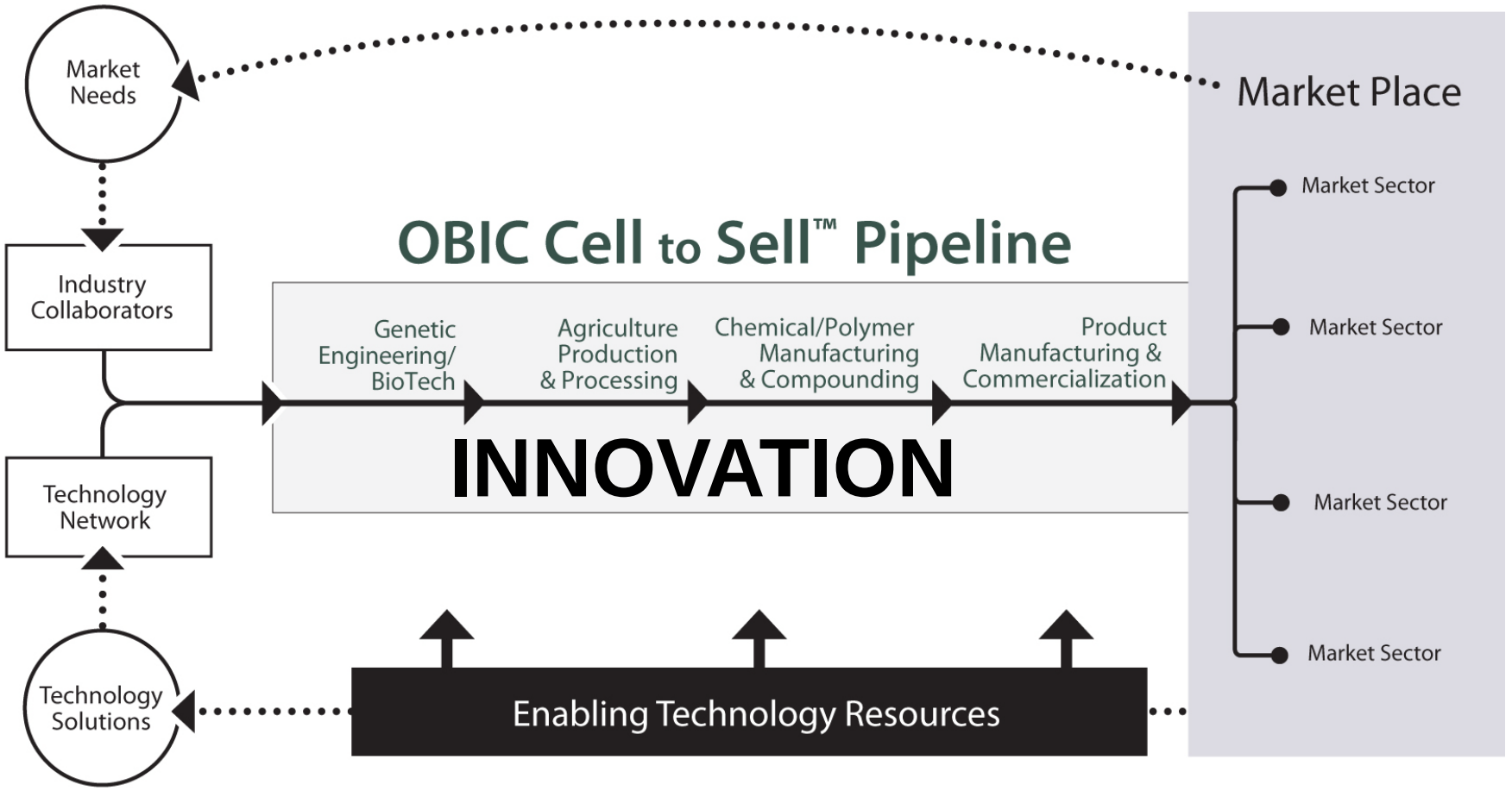
USDA United States Dept of Agriculture Agriculture Research Service

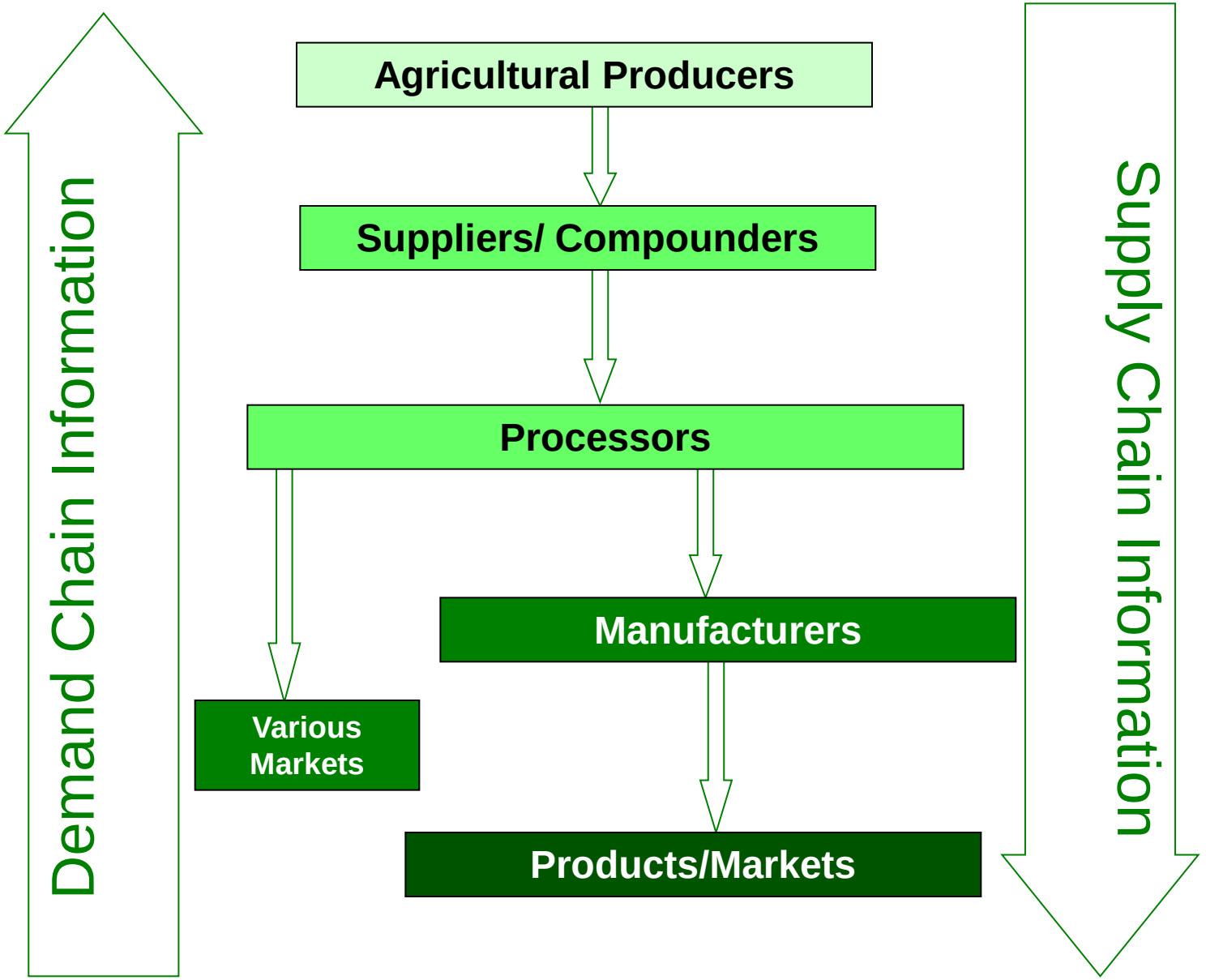
the Ohio Plant Biotechnology Consortium

Technical Capabilities

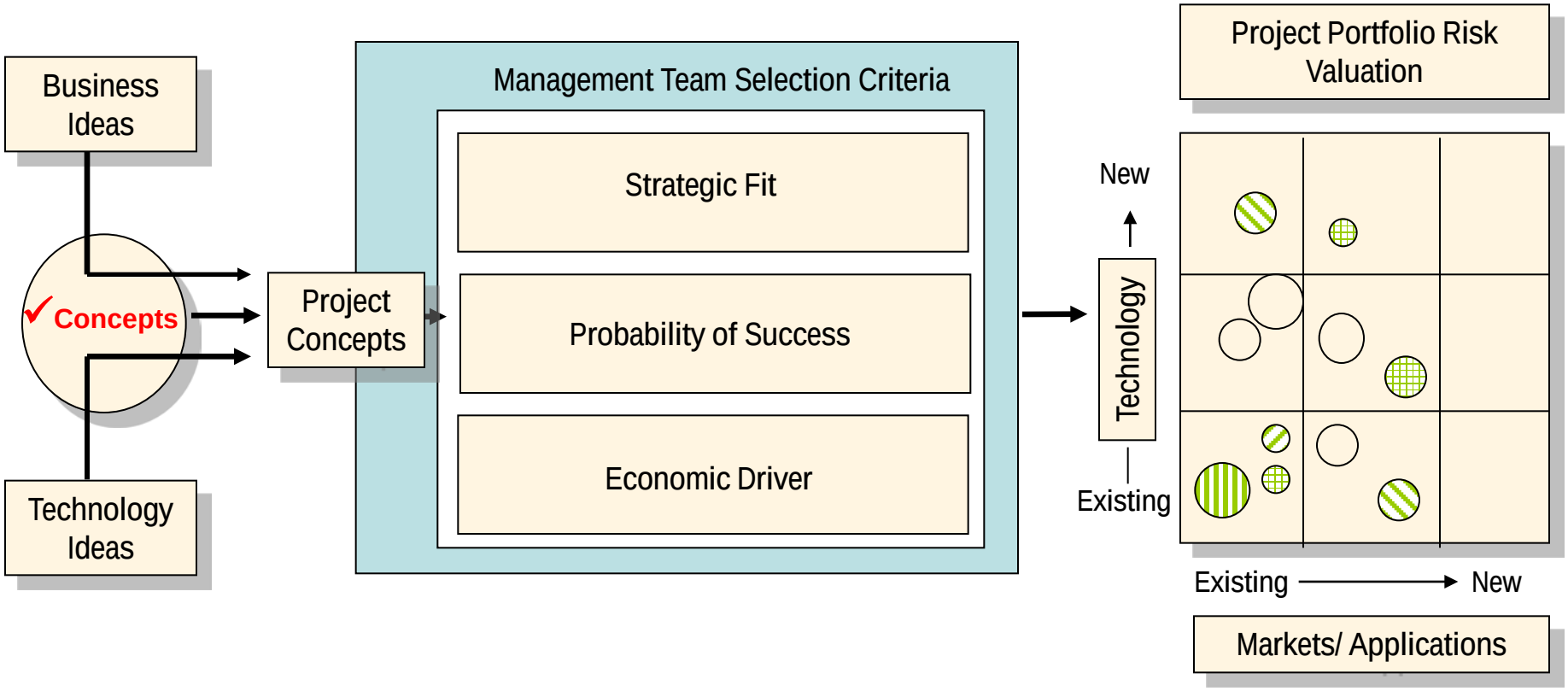


Market-Pull Model




Demand Chain Information
Agricultural Producers
Suppliers/ Compounders
Processors
Various Markets
Manufacturers
Products/Markets
Supply Chain Information

Project Validation & Selection



Business Idea Genesis → Opportunity Identification And Screening → Conceptual Business Case Development → Business Plan Development

Project Examples

- **Soybeans**
- **Natural Rubber**
- **Natural Fiber Reinforced Plastic**

Soybeans

A biological factory of…

- oil
- protein
- carbohydrates

Soybeans

Biotechnology to Chemistry

- Programs target desired plant traits for specific industrial applications
- Advanced equipment investment allows for **15,000x** faster DNA analysis.

THE OHIO STATE UNIVERSITY OARDC

SOY OHIO Ohio Soybean Council

USDA

Soybeans

Chemistry to Application

- Optimizing soy chemicals for industrial use
- Collaboration with Battelle's internationally recognized program in bioproduct development

THE OHIO STATE UNIVERSITY
DEPARTMENT of CHEMISTRY

Battelle
The Business of Innovation

OBIC Ohio BioProducts Innovation Center

Soybean Application

Plastic Additives

$5.8 billion market

Printer Toner

$9 billion market

R&D 100

SOY OHIO℠
Ohio Soybean Council

Battelle
The Business *of* Innovation

hp

Natural Rubber

Required for high performance applications

- aviation
- commercial trucks
- agriculture equipment
- automotive

Natural Rubber

Currently the US must import 100% of its natural rubber

Domestic alternative is needed!

Natural Rubber

Programs target domestication & application of alternative source:

Russian Dandelion

Taraxacum kok-saghz

The Ohio State University

Ohio Agricultural Research & Development Center (OARDC)

The University of Akron

Delta PLANT Technologies

COOPERTIRES

OBIC Ohio BioProducts Innovation Center

Fiber-Reinforced Plastic

Plastic is commonly reinforced to enhance performance
($25 billion market)

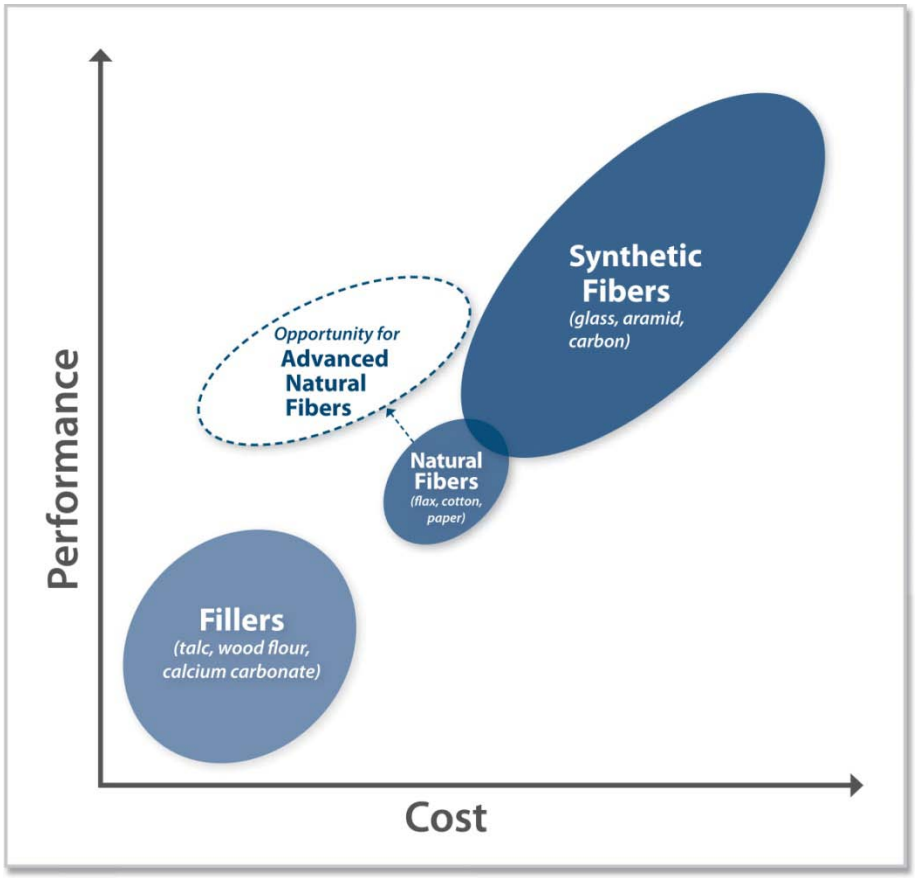
Wide range of applications:

- automotive
- furniture
- industrial

Fiber-Reinforced Plastic

Fiberglass is predominant plastic reinforcement

Breakthrough plant fiber provides alternative



NFCC Natural Fiber Composite Corp.

P&G ASHLAND

Natural Fiber

Program to develop plant-based fiber as alternative

- lighter, lower cost, increased performance
- renewable, environmentally-friendly

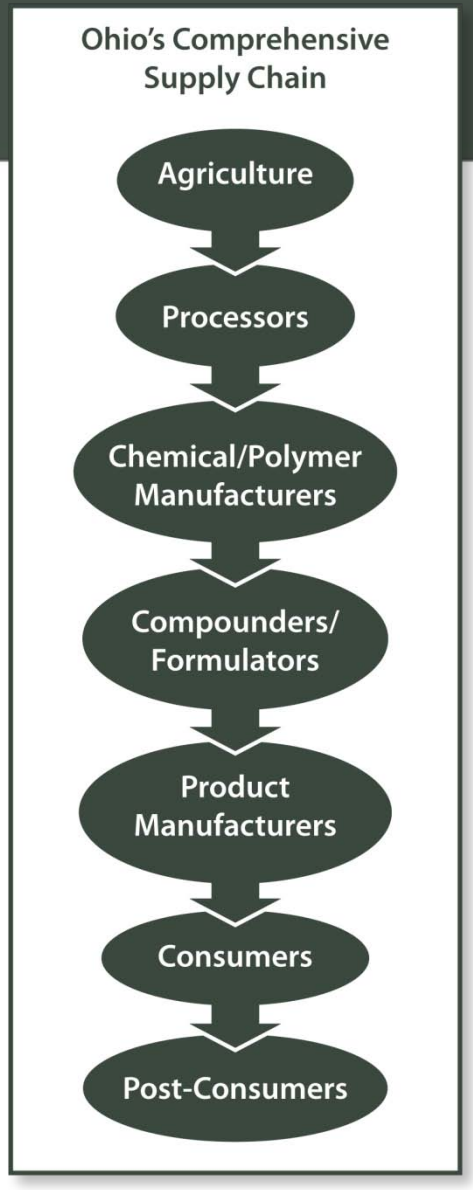
THE OHIO STATE UNIVERSITY College of Engineering &
Ohio Agricultural Research & Development Center (OARDC)

OBIC Ohio BioProducts Innovation Center

Strategic Position

Ohio & Great Lakes Region

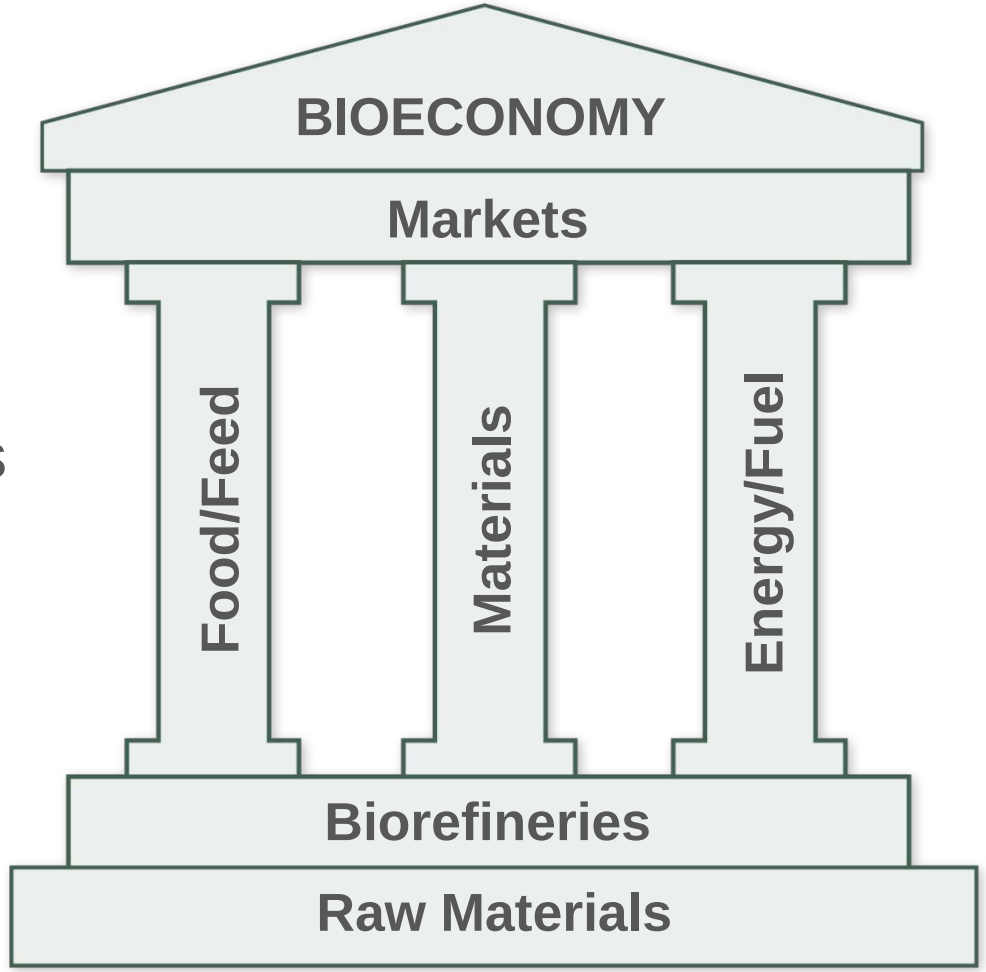
- Strong Polymer & Agriculture Sectors
- Supply Chain/Logistics in Place
- Strong Research Capabilities
- Natural Resources & Location



Integrated Bioeconomy

Economic Sustainability Requires

- Integrated Biorefineries
- Portfolio of Products
- Flexibility



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Processes

extraction/ separation

mechanical, chemical

bioconversion

microbes, algae

hydroloysis

acids, enzymes

gasification

high heat, low oxygen

pyrolysis

catalysis, heat, pressure

Uses

food

oil
proteins
carbohydrates
additives

fuels/energy

ethanol/butanol
biodiesel
heat
electricity

materials

plastics
fibers
adhesives
rubber
paints/coatings
dyes/pigments/ink
detergents/solvents

Lead the Way!

- “Race to the Moon” commitment
- Public/private networks essential for innovation
- Advocacy & leadership for common good
- Enhance economy, environment & quality of life

For more information…

bioproducts.osu.edu

Advocacy & Leadership

BioPolymer Advocacy

Wayne Earley
PolymerOhio

Sharell Mikesell
Ohio Polymer Strategy Council

Advocacy & Leadership

Rural Jobs Initiative

- Making Ohio a world leader in renewable energy & bioproducts

Jack Fisher
Ohio Farm Bureau Federation

OHIO FARM BUREAU

OCGA
OHIO CORN GROWERS ASSOCIATION

Ohio Soybean Association

Advocacy & Leadership

Turn Around Ohio Plan

- Establish Ohio as a leader
- Enhance bioeconomy
- Challenge industry to innovate

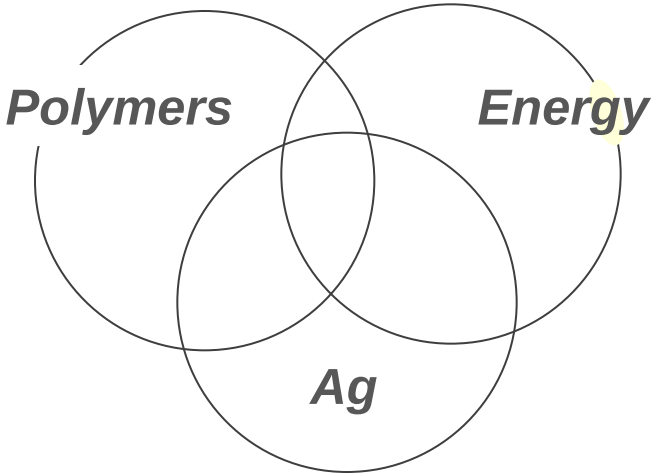
Ted Strickland
Governor

Robert Boggs
Ohio Dept. of Agriculture

Lee Fisher
Lt. Governor & Director of Ohio Dept. of Development

Industry & Technology

ECONOMIC SECTORS



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Biotechnology

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Sensors
Biochemistry

OUTCOMES

Growing Existing Companies

- Polymer & Ag
- Wind turbines
- Solar Energy
- Flexible Electronic Displays
- Energy Storage
- Medical devices

Building New Industries

- Biorefinery
- Smart materials
- Fuel Cells
- Hi-perf structures
- Drug delivery devices
- Nanofoams
- Biomass to Energy

Advocacy & Leadership

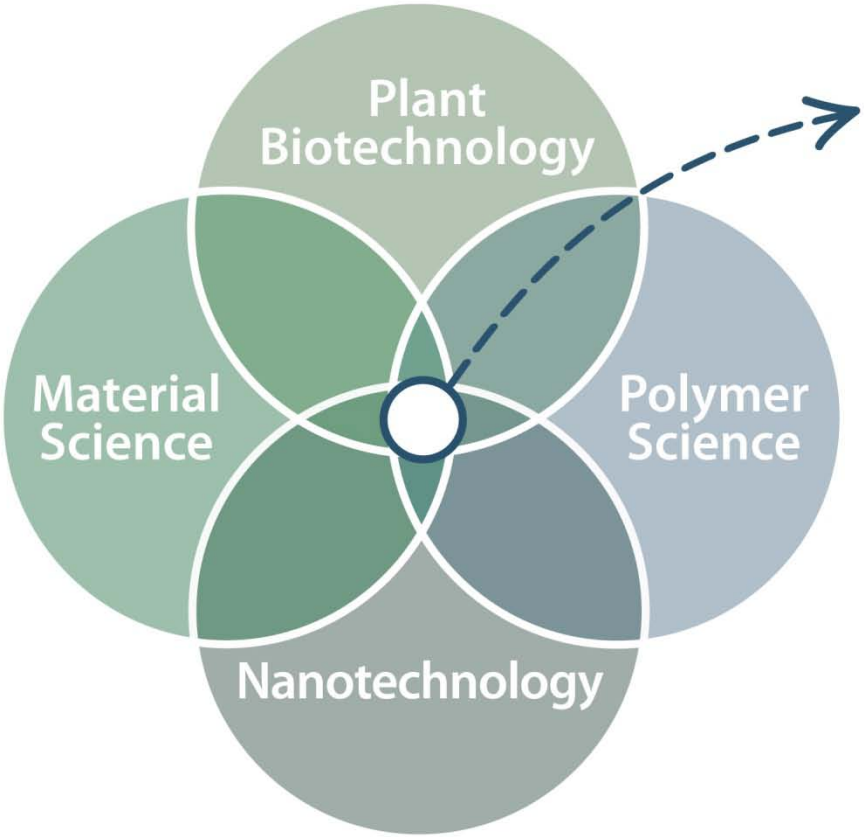
House Bill 233

- Ohio Agriculture to Chemicals, Polymers & Advanced Materials Task Force
- Passed Unanimously & signed by Gov. Strickland

Honorable Steve Reinhard

State Representative

Intersections of Technologies



- Energy & Conservation
- Electronics
- Information Technology
- Transportation
- Building & Construction
- Biomedcal

OBIC Concept Portfolio
n=118

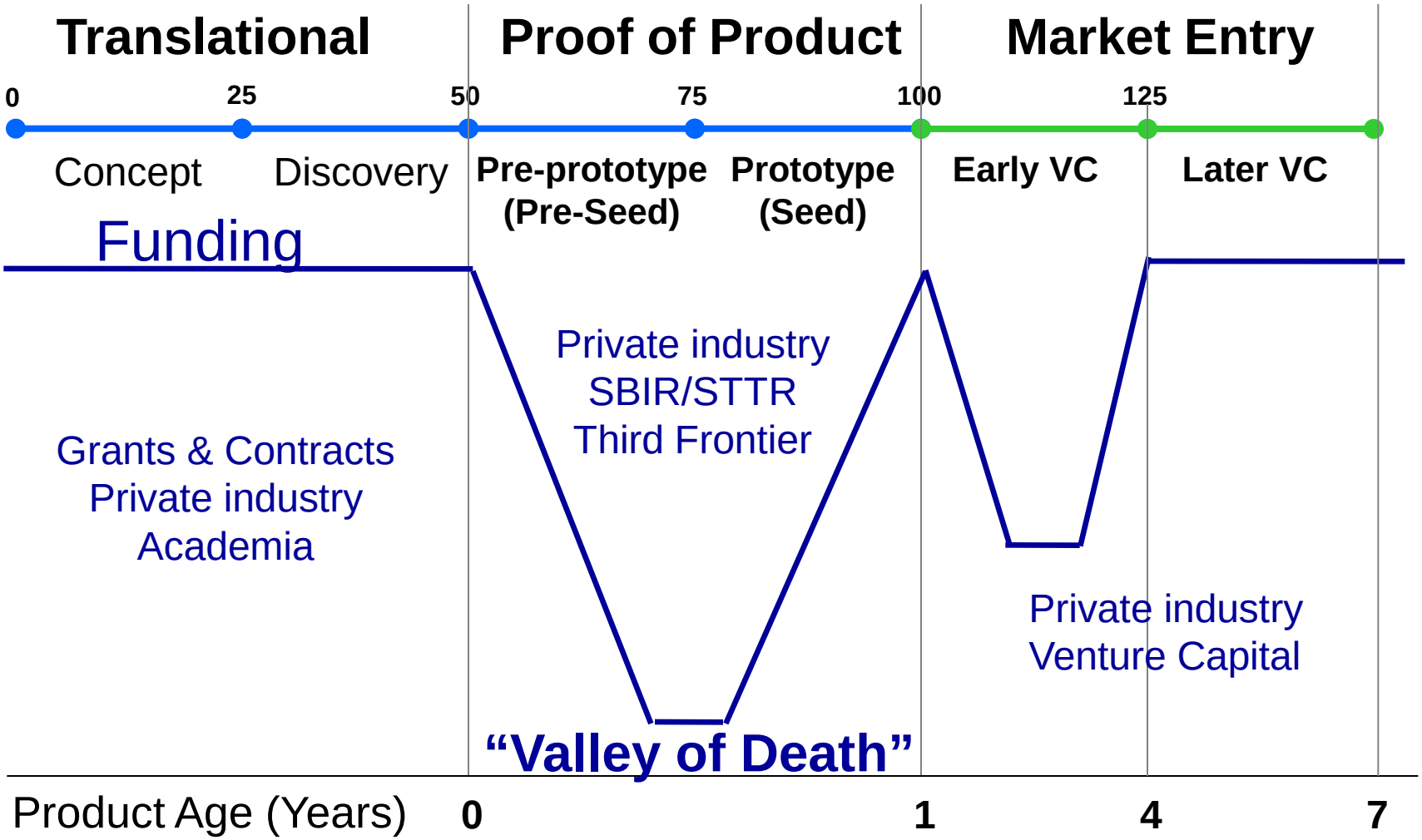
Innovation Type	<2 yrs (1)	3-5 yrs (2)	> 5 yrs (3)
Revolutionary (3)	0	3	4
New Product/ Process (2)	30	38	8
Modification (1)	28	5	2

Timeframe

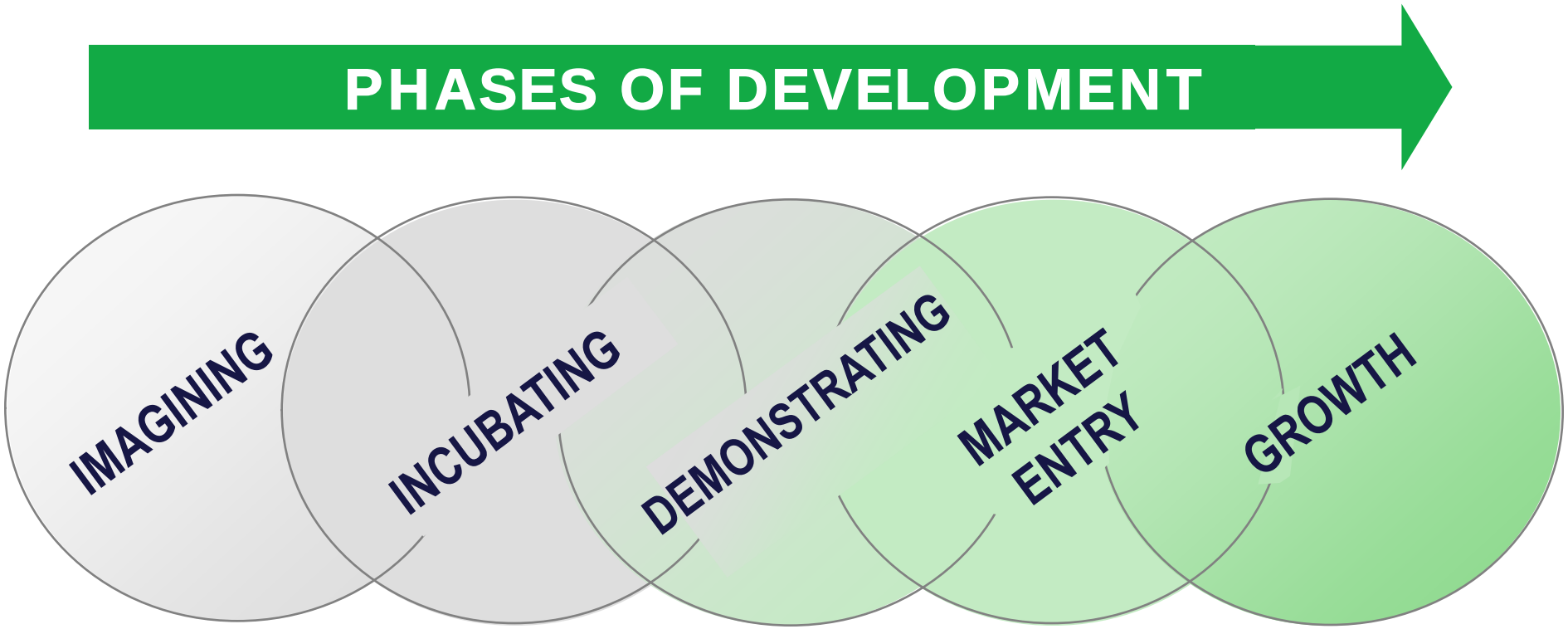
Strategy

- **Create Networks**
- **Enhance Capabilities**
- **Empower Leadership**

Process of Commercialization

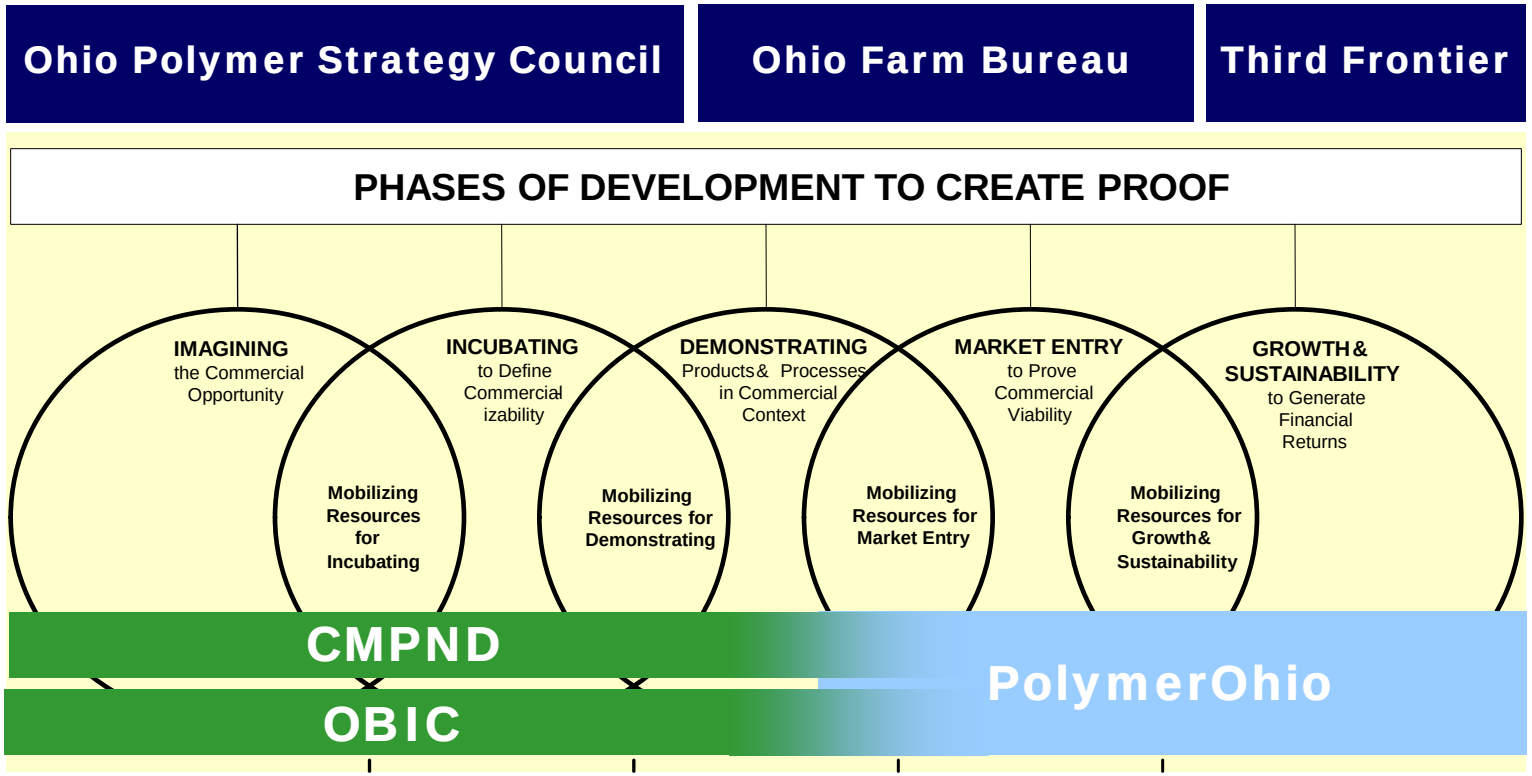


Innovation: Technology Commercialization



ODOD, adapted from Jolly, V.K. (1997)

Third Frontier Initiative catalyzes broader connections & stronger networks with proven commercialization processes and leadership



- Strategy & Policy
- Research & Applications Development
- Commercialization & Company Attraction

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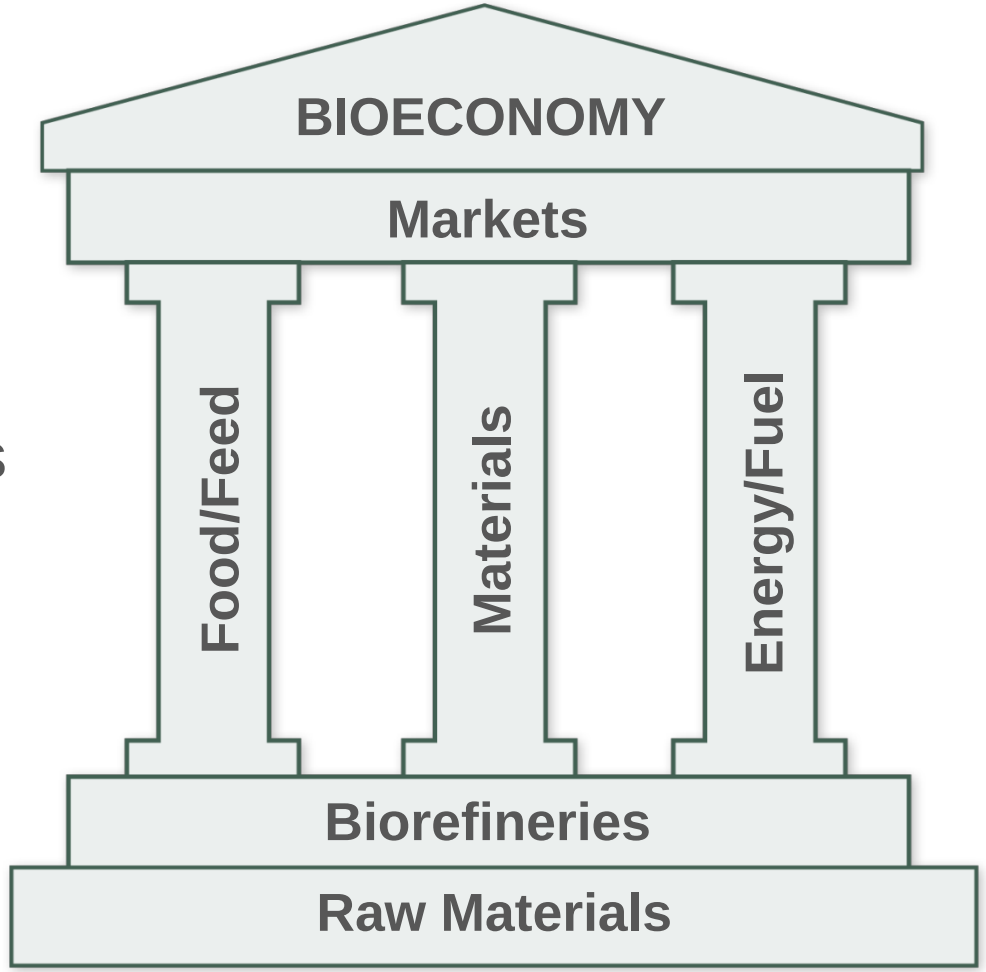

Technical Capabilities

Gaps:

- Materials-Flow Study
- Techno-Economic Analysis
- Proof-of-Concept
- Pilot-Scale Biorefinery
- Applications Development

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Technical Capabilities

Gaps:

- Materials-Flow Study ✓
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Pathway to Innovation